REMARKS

Reconsideration is respectfully requested, for the rejection of the claims as anticipated by FAGER (WO 96/09918, hereafter called D3) or ALLINGER et al. (DE 19747745, hereafter called D2) or ROWLEY et al. (WO 96/35960, hereinafter called D1).

To understand why these references do not anticipate nor even make obvious the present invention as now claimed, some background of the invention should be given as follows:

Within a number of fields there is a need to determine the position and/or orientation of a creature or of a part of the body of the creature, or of an object carried by the creature, relative to an environment.

For this object, today, there is a group of devices/methods which all rely on measuring the propagation times of signals for the determination of the position of the creature or an object associated to the creature. There are two main problems with these devices. First, they have very poor accuracy and second, they are not able to determine the orientation of the creature or the object, i.e., to determine how the creature or the object is directed relative the environment.

One device in this group is the very well known GPS, i.e. a satellite system for determining the position of for example ships, aircraft, land vehicles and/or individual persons, which system by means of known positions of a number of satellites and signal transmission from these to a receiving unit

can determine where the receiving unit is located. However, a GPS has several disadvantages. Firstly, these are that the system works well only in environments where few or no objects with unknown extension and/or density are located between the satellites and the receiving unit and where an inconsiderable reception of reflected waves is present, i.e. in practice only outdoors. This depends, as mentioned above, on the fact that the system is based on measuring the propagation time of the radio signals transferred and an assumption that the signal propagates through a certain known medium, in which the velocity of propagation of the signals is known, from the satellite straight to the receiving unit. For the reflected waves which a prolongation of the distance that the signals propagate, the propagation time from the satellite to the receiving unit will vary and will be longer than for non-reflected waves contributing to an inaccuracy of the system. This is the case for example when the receiving unit is located indoors and receives signals which are reflected against some object in the outdoor environment and then pass into the receiving unit via different windows. Furthermore, the system has a performance which means that the position of an object may in favorable cases be determined with a marginal error in the size of centimeters, if a so-called DGPS (Differential GPS) is used. In the case of moderate signal obstacles/signal propagation distance prolongations, often occurring in practice, a higher inaccuracy, in the size of

meters, is the result and with the receiving unit located indoors the system is in practice unusable, which means that for many applications the system is completely insufficient or unusable. A receiving unit of a GPS is not able to determine the orientation of a creature or another object.

For determining at least one orientation two or more receiving units, spaced relative to each other, on one and the same object, are required. By means of three receiving units all the six degrees of freedom of an object may be determined in some favorable cases. For small objects, such as creatures and objects of similar size, the orientation measurements will be very poor or not possible at all.

There is also another group of devices which rely on measuring the intensity of the signals received. The cited prior art described in WO 96/35960 (D1) belongs to this group. The system in D1 is able to determine also the orientation of an object. However, the system described in D1 has many disadvantages associated with the intensity measurements which will be described below.

In this connection, we would like to emphasize that by the present invention, which is based on direct angular measurements of the incident signals, for example by recording the incident positions of the signals received on a surface (using light) or by using phased arrays (using microwaves or acoustic waves), this device is substantially independent of both

the propagation time and the intensity of the signals received. Thus, it is possible to determine the position and/or orientation with a very great accuracy. In some cases with accuracy in the magnitude of 1/10 of a millimeter, or better, as regards the position and 1/10 of a mrad, or better, as regards the orientation.

Against this background, it will be seen that the applied references relate to different problems and solutions from those of the present invention.

D1 may be the closest prior art. D1 describes a system and a method for determining the position and orientation of a creature provided with a headset, which creature is movable relative to an environment. For this purpose, transmitter units are located in the environment and receiver units are arranged on the headset of the creature.

The transmitter units are built up a pyramids, and each of three sides of such a pyramid is provided with a transmitter in the form of a light emitting diode (LED) working with infrared light.

The receiver units have a body with a number of surfaces which are tilted relative to each other. Each surface is provided with a photo detector for detecting infrared light emitted by the diodes of the transmitter units. When the signals are received such surfaces are used in groups containing three surfaces for detecting the current signal.

Each diode of the transmitter units emits bursts of eight pulses of infrared light at 125 kHz.

The basis principle for detecting the signals transmitted by the transmitter unit is recording of the intensity of the signals. By means of the photo detractors the intensity of the radiation, recorded by the photo detector, is proportional to cosine for the incident angle of the radiation relative to the current photo detector. By comparing the intensity measurements within a group the orientation can then be estimated.

This device using intensity measurements is, however, completely different compared to the device according to the present invention.

The device according to the invention defined in the independent claim 4 uses a transducer which determines its position and/or orientation, and thereby the position and/or orientation of a creature or a body part thereof, by means of a surface designed to receive signal transmitted from the signals sources and to record the relative incident positions of the received signals on the surface.

This is a way of working which relies on a completely different principle than the system according to D1. The basic principle is direct angular measurements of signals. The fact is that the transducer according to the invention is substantially independent of the intensity of the signals for accomplishing the position and/or orientation determination.

Furthermore, the device includes at least one reference defined by the introduction of at least condition regarding the position and/or orientation of the transducer relative to the environment for creating an abstract station. Such a reference is not mentioned in D1.

Thus, the invention defined in claim 4 is unobvious over D1.

The invention defined in the independent claim 5 uses a transducer which determines its position and/or orientation, and thereby the position or orientation of a creature, by means of a surface designed to receive signals transmitted from the signals sources and to record relative incident positions of the received signals on the surface.

In addition, the locating member comprises a sensor for obtaining information from the environment by recording or measuring one or more properties of the environment in one or more positions and/or directions.

Thus, the invention defined in claim 5 is unobvious over D1.

The device according to the invention defined in the independent claim 1 uses a transducer provided with a phased-array for receiving the signals and recording the relative incident directions of the signals relative to the transducer.

Also this device works with direct angular measurements of signals in a way completely different from the measurements of

intensity according to D1. A so called phased-array works with recording of incident directions of signals relative to said phased-array by measuring the phase position of the received wave front of the signal and is also substantially independent of the intensity of the signals.

Thus, the invention defined in claim 1 is unobvious over D1.

A problem with the system according to D1 is its limited capacity as regards to what extent a creature provided with the receiver units can move freely in an environment and take different positions and orientations while maintaining a sufficient accurate position- and/or orientation determination or a position- and/or orientation determination at all. The capacity is especially low in environments which involve that the signals from the transmitter units are reflected and/or blocked by different obstacles or are irregularly damped (mirrors, windows, metal surfaces, bright painted surfaces, steam or fog in the air, etc.).

By using a transducer according to the invention which utilizes the fact that there is a connection between the incident positions of the signals on the transducer on one hand, and the position/orientation of the transducer relative to the signal sources which generate the current signals on the other hand, the transducer can be designed in such a way so it becomes substantially independent of the intensity of the signals, the

distance to the signal sources as well as of the propagation time of the signals between the signal source and the transducer. This in turn gives the possibility to give a creature which is provided with such a transducer a greater freedom of movement together with a maintained or improved position- and/or orientation determination.

Conclusions may be drawn about the incident directions of the current signals relative to the transducer by recording the incident positions and knowledge about the positions of the signals sources in the environment, and by using mathematical calculations. The points or incident positions may be obtained by means of for example a lens depicting the environment on for example a CCD.

A great advantage with this technique is that in a system where a greater number of points or positions are obtained on the surface than what is necessary for calculating the desired number of degrees of freedom of the transducer, it may be calculated if there is any reflected signal which shall be discriminated or not, which reflected signal otherwise would give rise to errors in the position- and/or orientation determination if not being discriminated. This in turn results in a much greater freedom of movement for the creature while enabling the desired position- and/or orientation determination to be accomplished.

By the fact that the transducer is substantially independent of the intensity of the signals a large number of different types of signal sources or combinations thereof may be used in the application of the invention. Such signal sources are for example active as well as passive signal sources including signal sources naturally occurring in the environment, which enables the use of unprepared rooms in certain embodiments of the invention.

The characteristics according to the invention described above results in a totally different flexibility and capacity compared to the system according to D1.

The system according to D1, such as previously described, relies on measuring intensities of the incident signals and on comparing the intensity of "one and the same signal" which reach at least two surfaces having different directions, the signals having different intensity depending on which surface is studied, for calculating the incident direction of the signal, which in turn means that several approximations have to be made, and in addition that many measurement errors could arise. In this connection, the choice of different types of signal sources is also strongly limited.

As one example only, it may be mentioned that the intensity 1 is proportional to $1/R^2$, where R is the distance between the signal source and the detector. In the case of a signal source which emits signals, the intensity 1 is in practice

direction dependent. If the measurement is not performed at a very long distance from the signal source, this will cause a measurement error. If the signal source is not totally point-shaped, i.e. the signal source does not transmit signals completely isotropically, it has to be that $L/R<<1$, where L is the distance between the measurement surfacees has to be much less than the distance to the signal source. Furthermore, in case of a large R the dynamics of the measurement is poor, since it is proportional to $1/R^2$. Thus, there are disadvantages with a large R as well as with a small R.

Although the device according to the invention may be used in many different applications, one important application is within the field of guarding or security business where there is a need to determine the position and/or orientation of a guard with the purpose of checking, monitoring and/or supervising the movements of the guard, or different actions which are taken by the guard, during a so-called guard path. In accordance with prior art, this is performed by the fact that the guard is imposed to perform an action, such as turning a key or accomplishing a reading of a bar code, at certain predetermined locations (control stations) along the guard path, which confirms that the current guard has been at the current place at a certain moment.

Service of machines and visits to public buildings, shops, etc. are other examples of similar situations where it

could be a need to determine the position and/or orientation of a person, or a body part thereof, at different moments, for example to supervise the person.

However, the prior art equipment lacks flexibility and the control stations used for supervising or verifying the activities of a creature are stationary and/or require that the creature perform some kind of action besides that the creature is in a certain position.

By providing a reference (as in claim 4) defined by the introduction of at least one condition regarding the position and/or orientation of the transducer relative to the environment for creating an abstract station, a "control station", the position in the room, which room may be arbitrarily chosen, may be created and used to verify that the body part of the creature which is connected with the transducer is located in the current position and/or has an orientation corresponding with the current condition which condition could be time dependent. In this way, "control stations, control areas and control volumes" may be created substantially independent of the physical characteristics of the room and they may be moved and altered as desired.

The characteristics of the device according to the invention give a totally different flexibility and capacity than stationary control stations according to prior art.

In the applications mentioned above, it could also be a need for locating other phenomena including such which are not

possible to indicate visually when for example a guard moves along a guard path.

By using a device (as in claim 5) comprising a locating member having a sensor for obtaining information from the environment by recording or measuring one or more properties of the environment in one or more positions and/or directions, the position- and/or orientation determination of the creature may be combined with the results given from the sensor to obtain more information about the conditions at a certain position and/or in a certain direction. In the guard case for instance, the sensor may be for example a radiation detector for detecting and locating a radioactive leakage. It is also possible to provide the locating member with a camera, such as a video camera, with the purpose of obtaining further information by picture recording of the environment in connection to the position- and/or orientation determination.

By providing a device (as in claim 1) having a transducer provided with at least one phased-array measuring the relative phase angle within the received wave front of the signal, thereby determining the incident angles of the signal, it is possible to record the incident directions of the signals in a way which is independent of the intensity. That is to say, the transducer may be designed to be substantially independent of the intensity of the signals, the distance to the signal sources as well as the propagation time of the signals between the signal

source and the transducer. This in turn gives the possibility to give the creature which is provided with such a transducer a greater freedom of movement together with a maintained or improved position- and/or orientation determination. In the same way as described above in connection with the discussion about claims 4 and 5, the embodiment using a phased-array (for the requisite position- and/or orientation determination) results in several further advantages as regards discrimination of signals and the use of different types of signal sources.

A phased-array may for example be constituted by several microwave aerials when signals in the form of microwaves are used by several crystals when signals in the form of ultrasonic waves are used.

Although D2 very briefly mentions some different measurement methods, D2 seems to belong to the "GPS-group" using measurement of the propagation times of signals, or taking the bearings to the object from some fixed locations in the environment, for the determination of the position of the creature or an object associated to the creature. D2 does not disclose a phased-array or a surface designed to receive signals and record the relative incident positions of the signals received on the surface. Neither is a reference as in claim 4 or a sensor as in claim 5 disclosed.

D3 describes a control system for controlling industrial equipment and does not say anything about a phased-

array as in claim 1, a reference as in claim 4 or a sensor as in claim 5. More precisely, D3 describes a control system using a joy-stick for controlling for example industrial robots. Also other equipment, such as a marker on a computer screen may be controlled. Whether the control member is carried by hand or placed on a helmet, the object of the control system is to control industrial equipment by means of the control member.

Furthermore, the control system of D3 includes a transducer, which transducer has a surface on which the positions of the incident signals are recorded for determining the position and/or orientation of a control member, such as a joy-stick, indeed, but a person skilled in the technical field concerning position- and/or orientation determination of a creature, which creature has to be able to move freely in the room while maintaining the possibility to determine the position and/or orientation of the creature, cannot be expected to seek knowledge about a suitable transducer within the technical field of controlling industrial equipments.

Accordingly, the invention defined in claims 1, 4 and 5 is also novel and unobvious and more patentable over the devices described in D2 and D3.

In short:

D3 of Fager (p. 10, line 6-line 29; p. 19, line 12-p.21, line 12; Fig. 2, 8, and 9) says nothing about a phased-

array as in claim 1, a reference as in claim 4 or a sensor as in claim 5.

D2 of Allinger(col 2, line 60-col 3, line 8; Fig. 1) says nothing about a phased-array or a surface designed to receive signals and record the relative incident positions of the signals received on the surface. Neither is a reference as in claim 4 or a sensor in claim 5 disclosed.

D1 of Rowley (p. 18, line 17-p. 19, line 18; Fig. 8, 10) says nothing about a phased-array or a surface designed to receive signals and record the relative incident positions of the signals received on the surface. Neither is a reference as in claim 4 or a sensor as in claim 5 disclosed.

The claims that depend from claims 1, 4 and 5 are patentable because of that dependency and also by virtue of the further features of set novelty that they separately recite.

In view of the above, therefore, it is believed that this application is in condition for allowance, and passage to issue is respectfully requested.

The Commissioner is hereby authorized in this, concurrent, and future replies, to charge payment or credit any

overpayment to Deposit Account No. 25-0120 for any additional fees required under 37 C.F.R. § 1.16 or under 37 C.F.R. § 1.17.

Respectfully submitted,

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